REMARKS

[3] Claims 1-3 were rejected over Jones '337 in view of Carr. This rejection is respectfully traversed.

(1) The Examiner points to Jones' disclosure of ion bombardment etching and asserts that Carr also discloses ion bombardment etching. The Applicant disagrees because Carr discloses etching in a dilute HF bath, or plasma assisted chemical etching (PACE), for the purpose of exposing sub-surface defects. These etches are disclosed on the second and third text pages. No disclosure of etching by ion bombardment is seen by the Applicant, and the Examiner is requested to provide a citation if he maintains that Carr also discloses ion bombardment etching.

(2) The chemical processes used by Carr actually *increase* the roughness; this is shown by Table I on the sixth text page. "A sharp increase in roughness is noted as the surface is etched from 0 to 80 nm," writes Carr just above Table I, and on the following page adds, "Further etching causes additional roughening." Since Jones is sharpening a blade with its ion bombardment etching, not testing like Carr, and the person of ordinary skill would not have substituted Carr's chemical process that increases the surface roughness and therefore decreases sharpness.

It is noted that Jones teaches chemical etching as a step preliminary to ion bombardment. Chemical etching is disclosed starting at column 2, line 44. Jones states at column 3, line 23, that "A combination of abrasive methods and

chemical methods may be used to form the desired *shape* of cutting edge" (emphasis added), and at column 3, line 45, explains, "One of the above described methods may be used to form the desired finished cutting edge. However, a final shaping and finishing can be provided, for example, by ion bombardment." Jones teaches away from chemical etching as a final step in sharpening a blade.

(3) Carr is from the area of testing optical surfaces and has no disclosed relationship to blades, and the Applicant sees no teaching about optical surfaces in Jones. It is the Applicant, not Jones or Carr, who relates optical surfaces and blades. It is the Applicant, not the person of ordinary skill, who saw the relationship.

(4) The Examiner points out the surface roughnesses disclosed in Table II on the last page of Carr. With respect, this data relates to diamond-turned optical surfaces (see preceding page) which have been etched by Carr's chemical methods. There is no relationship to ion bombardment, or the blade of Jones. It is noted that Table II, like Table I, also discloses that Carr's processes increase the roughness.

(5) Claim 1 now recites that the plate is of harder material than the substrate. Carr discloses no plating material, while Jones uses alumina for the substrate and discloses a coating of chromium on the alumina at column 5, line 12, as noted by the Examiner. But chromium is not harder than alumina, and there is no anticipation of the new feature. The Examiner is referred to the

attached photocopies from a dictionary and the Handbook of Chemistry and Physics.

Alumina is another name for corundum or aluminum oxide (dictionary). Alumina defines the hardness of 9 on the Mohs scale of hardness, and the Mohs hardness of chromium is 9.0 (handbook), exactly the same as the alumina substrate. On the Knoop scale of hardness, the hardness of alumina is 2100 and the hardness of chromium is 935 (handbook). Thus on one hardness scale there is no difference in hardness, while on the other scale the substrate is more than twice as hard as the coating.

As there is no disclosure of the feature now claimed in either reference, no combination would reach the claims even if the combination were obvious (not admitted).

The other coatings disclosed by Jones, such as polymer, are not harder than the alumina substrate. The Applicant respectfully traverses the Examiner's characterization of polymer as "hard" and requests a citation in support if the Examiner is to maintain that polymer might be harder than alumina.

(6) Claim 1 as amended recites the plate extending to the cutting edge on a single side of the blade. This is not disclosed by Jones, which presents the formation and sharpening of the blade as steps preliminary to coating. The Applicant sees no disclosure of the coatings being formed on a single side of the blade. Jones says that the coatings are applied "in the vicinity of the cutting edge" (column 5, line 9), but that does not imply the Applicant's feature.

(7) The Applicant sees no disclosure of the subject matter of claim 2, and the Examiner has not pointed out where in the references that subject matter might be.

[4] Claim 4 was rejected over Jones '337 in view of Carr and Lane. This rejection is respectfully traversed. The Applicant assumes that the Examiner meant Lane et al. '379, not Lane '329.

Lane '379 teaches glass for a coating, not for a substrate, and therefore does not anticipate claim 4. It is noted that Lane et al. teaches against the new feature of claim 1, that the plate extends to the cutting edge on a single side of the blade.

[5] Claim 5 was rejected over Jones '337 in view of Carr and Lane. This rejection is respectfully traversed on the grounds above relating to the base claim, and on the further grounds that Jones discloses polymer is for lubricity, and substituting ceramic for the polymer would not improve lubricity.

[6] Claim 6 was rejected over Jones '337 in view of Carr and Fischbein '342. This rejection is respectfully traversed on the grounds above relating to the base claim, and on the further grounds that the thickness of a polymer layer is immaterial to any hard layer such as a chromium layer, so there is no teaching toward the Applicant's claims.

Allowance of all claims under consideration is respectfully solicited.

Respectfully submitted,

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Attachment **(FOUR PAGES)**: Pages from dictionary and handbook.

I hereby certify that this correspondence is being facsimile transmitted to the Patent and Trademark Office (Fax No. (703) 872-9302) on August 22, 2002.

Nick Bromer (reg. no. 33,478)

Signature Nick Bromer

al·tim/i trē), *n.* the science of measuring y altimeters. [ALTI- + -METRY] —al·ti·/ta me/tri kəl), *adj.* —al/ti·met/ri·cal-

'al tis/ə mō/; *It.* äl tēs/sē mō/), *Music.* high. —*n.* **2.** in altissimo, in the second he treble staff. [< It: lit., highest, equiv. + *-issimo* superl. suffix]

'ti tōōd/, -tyōōd/), *n.* **1.** the height above y point on the earth's surface or in the **2.** extent or distance upward; height: *The ns are not of great altitude.* **3.** *Astron.* the ce of a heavenly body above the horizon. e perpendicular distance from the vertex the side opposite the vertex. **b.** the line rtex of a figure perpendicular to the base. titudes. a high point or region: *mountain* igh or exalted position, rank, etc. [< L v. to *alt(us)* high + -i- -I- + *-tūdō* -TUDE] **height.** —**Ant.** **2.** depth.

'al, an adjustable sundial utilizing the sun, at a given latitude and time of year, telling the time. Cf. **direction dial.**

l (al/ti tōōd/ᵊnᵊl, -tyōōd/-), *adj.* relating height. [< L *altitūdin-* (s. of *altitūdō*) .L¹]

., *pl.* -tos, *adj.* *Music.* —*n.* **1.** the lowest contralto. **2.** the highest male voice; **3.** a singer with such a voice. **4.** a musi- ch a voice. **5.** the second highest of the mixed vocal chorus, or the voices or per- is part. **6.** the second highest instrument usical instruments, as the viola in the vio- the althorn in the cornet family. —*adj.* ertaining to, or having the tonal range of d a musical instrument) second highest in sical instruments: *alto saxophone.* [< It) high]

alti-: *altostratus.*

Music. a sign locating middle C on the he staff. Also called **viola clef.** See illus. clef.

us (al/tō kyōō/myə ləs), *n.*, *pl.* -lus. ud of a class characterized by globular in layers or patches, the individual ele- rger and darker than those of cirrocumu- than those of stratocumulus: of medium t 8000–20,000 feet. [ALTO- + CUMULUS]

us **castella/nus,** *pl.* altocumulus cas- *orol.* an altocumulus cloud having its d like a crenelated tower. Also, **al/to- ella/tus.**

us **floc/cus,** *pl.* altocumulus floccus. tocumulus cloud having its summit in the cumuliform tufts or masses.

us **lenticular/is,** *pl.* altocumulus len- *teorol.* an altocumulus cloud having at its y outlined lenticular shapes and some- irisation.

us **stratifor/mis,** *pl.* altocumulus *Meteorol.* an altocumulus cloud consisting or more horizontal layers.

(ôl/tə geth/ər), *adv.* **1.** wholly; entirely; ite. **2.** with all or everything included: nted *altogether to twenty dollars.* **3.** with ing considered; on the whole: *Altogether,* er. —*n.* **4.** in the altogether. *Informal.* *e phone rang she had just stepped out of the s in the altogether.* [var. of ME *altogeder.* HER] —al/to·geth/er·ness, *n.*

OGETHER and ALL TOGETHER are some- d. As an adverb, ALTOGETHER means letely, entirely" (*an altogether confused* ALL TOGETHER, as an adjective phrase, oup" (*They were all together in the kitchen*).

althorn.

n. **1.** a city in SW Illinois. 43,047 (1960). n name.

nä), *n.* a metropolitan district of Ham- rmany: formerly an independent city.

ōō/nə), *n.* a city in central Pennsylvania.

a town in NW Georgia. 2526 (1960).

o (al/tō ri lē/vō), *n.*, *pl.* -vos. See high alto-rilievo.

(äl/tō rē lye/vō), *n.*, *pl.* al·ti·ri·lie·vi), *Italian.* See **high relief.**

(al/tō strā/təs), *n.*, *pl.* -tus. *Meteorol.* ass characterized by a generally uniform layer, lighter in color than nimbostratus n cirrostratus: of medium altitude, about et. [ALTO- + STRATUS]

rish/əl), *adj.* *Ornith.* helpless at hatching parental care for a period of time. Cf. NL *altricial(is),* L *altrici-* (s. of *altrix*) iv. to *al-* feed (see ALIMENT) + *-trici-* gency + *-ālis* -AL¹]

'trōō iz/əm), *n.* the principle or practice ncern for or devotion to the welfare of d to *egoism*). [< F *altruisme* < It *altrui* f L *alteri*) + F *-isme* -ISM]

rōō ist), *n.* a person unselfishly concerned l to the welfare of others (opposed to formation from ALTRUISTIC]

l/trōō is/tik), *adj.* unselfishly concerned to the welfare of others (opposed to *ego- ist*) + -ISTIC] —al/tru·is/ti·cal·ly, *adv.* le, generous, philanthropic; disinterested.

ör/əs), *n.* a town in NE California. 2819

n. a city in SW Oklahoma. 21,225 (1960).

ō dəl/), *n.* *Chem.* one of a series of pear- of earthenware or glass, open at both ends above the other, for recovering the subli-

al·um (al/əm), *n.* *Chem.* **1.** Also called **aluminum potassium sulfate, common alum, potash alum, potas- sium alum.** a colorless, odorless, crystalline, water- soluble solid, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$, a double sulfate of aluminum and potassium, used in medicine as an astringent and styptic, in dyeing and tanning, and in many technical processes. **2.** one of a class of double sulfates analogous to the potassium alum, having the general formula $R_2SO_4 \cdot X_2(SO_4)_3 \cdot 24H_2O$, where R is a univalent alkali metal or ammonium, and X one of a number of trivalent metals. **3.** (not in technical use) aluminum sulfate, $Al_2(SO_4)_3$. [ME < MF < L *alūm(en)*; r. OE *ælefne* (or **ælymne* < L *alūmini-* (s. of *alūmen*)]

alum., aluminum.

alumin-, var. of alumino-, esp. before a vowel.

a·lu·mi·na (ə lōō/mə nə), *n.* the natural or synthetic oxide of aluminum, occurring in nature in a pure crystal form as corundum. Also called **aluminum oxide.** [pl. of L *alūmen* alum]

alu/mina cement/, a quick-setting cement with a large bauxite content.

a·lu·mi·nate (ə lōō/mə nāt/), *n.* **1.** *Chem.* a salt of the acid form of aluminum hydroxide, containing the group AlO_2^- or AlO_3^{-3}. **2.** *Mineral.* a metallic oxide combined with alumina. [ALUMIN- + -ATE²]

alu/mina trihy/drate, *Chem.* a white, crystalline, water-insoluble solid, $Al_2O_3 \cdot 3H_2O$, used chiefly in the synthesis of aluminum salts.

a·lu·mi·nif·er·ous (ə lōō/mə nif/ər əs), *adj.* containing or yielding aluminum. [ALUMIN- + -I- + -FEROUS]

a·lu·mi·nise (ə lōō/mə nīz/), *v.t.*, -nised, -nis·ing. *Chiefly Brit.* aluminize.

a·lu·mi·nite (ə lōō/mə nīt/), *n.* a mineral, hydrous aluminum sulfate, occurring in white, chalky masses. Also called **websterite.** [ALUMIN- + -ITE¹]

al·u·min·i·um (al/yə min/ē əm), *n.*, *adj.* *Chiefly Brit.* aluminum.

a·lu·mi·nize (ə lōō/mə nīz/), *v.t.*, -nized, -niz·ing. to treat with aluminum. Also, *esp. Brit.*, **aluminise.** [ALUMIN- + -IZE]

alumino-, a combining form of aluminum, used esp. before a consonant: *aluminosilicate.* Also, *esp. before a vowel,* **alumin-.**

a·lu·mi·nog·ra·phy (ə lōō/mə nog/rə fē), *n.* *Print.* algraphy. [ALUMIN- + -O- + -GRAPHY] —a·lu·mi·no·graph·ic (ə lōō/mə nə graf/ik), *adj.*

a·lu·mi·no·sil·i·cate (ə lōō/mə nō sil/ə kit, -kāt/), *n.* any naturally occurring or synthetically produced aluminum silicate containing alkali-metal or alkaline-earth-metal ions, as a feldspar, zeolite, or ultramarine. [ALUMINO- + SILICATE]

a·lu·mi·no·ther·my (ə lōō/mə nō thûr/mē), *n.* *Metall.* a process of producing high temperatures by causing finely divided aluminum to react with the oxygen from another metallic oxide. Also, **a·lu/mi·no·ther/mics.** [ALUMINO- + -THERMY]

a·lu·mi·nous (ə lōō/mə nəs), *adj.* of the nature of or containing alum or alumina. [< L *alūminōs(us)*, equiv. to *alūmin-* (s. of *alūmen* ALUM) + *-ōsus* -OUS] —a·lu·mi·nos·i·ty (ə lōō/mə nos/i tē), *n.*

a·lu·mi·num (ə lōō/mə nəm), *n.* **1.** *Chem.* a silver-white metallic element, light in weight, ductile, malleable, and not readily oxidized or tarnished, occurring combined in nature in igneous rock, shale, clay, and most soil: used in alloys and for lightweight utensils, castings, airplane parts, etc. *Symbol:* Al; *at. wt.:* 26.98; *at. no.:* 13; *sp. gr.:* 2.70 at 20°C. *Abbr.:* alum. —*adj.* **2.** of, pertaining to, made of, or containing aluminum: *an aluminum frying pan.* Also, *Brit.*, **aluminium.** [< NL, alter. of *alumium.* See ALUMINA, -IUM] —al·u·min·ic (al/yə min/ik), *adj.*

alu/minum ac/etate, *Chem.* a compound which in the form of its normal salt, $Al(C_2H_3O_2)_3$, obtained as a white, water-soluble, amorphous powder, is used chiefly in medicine as an astringent and as an antiseptic, and which in the form of its basic salt, $Al(C_2H_3O_2)_2OH$, obtained as a white, crystalline, water-insoluble powder, is used chiefly in the textile industry as a waterproofing agent, as a fireproofing agent, and as a mordant.

alu/minum ammo/nium sul/fate, *Chem.* a colorless, crystalline, water-insoluble solid, $AlNH_4(SO_4)_2 \cdot 12H_2O$, used chiefly as a size in the manufacture of paper; alum. Also called **ammonium alum, ammonia alum.**

alu/minum bo/rate, *Chem.* a white, granular, water-insoluble powder, $2Al_2O_3 \cdot B_2O_3 \cdot 3H_2O$, used chiefly in the manufacture of crown glass.

alu/minum borohy/dride, *Chem.* a volatile liquid, $Al(BH_4)_3$, that ignites spontaneously in air and reacts vigorously with water to form hydrogen, used chiefly in organic synthesis.

alu/minum brass/, an alloy of about 76 percent copper, 2 percent aluminum, small amounts of other elements, and the balance zinc.

alu/minum bronze/, any of several alloys containing a high percentage of copper with from 5 to 11 percent aluminum and varying amounts of iron, nickel, manganese, and other elements. Also called **albronze.**

alu/minum car/bide, *Chem.* a yellow, crystalline solid, Al_4C_3, that reacts with water to form methane.

alu/minum chlo/ride, *Chem.* a yellow-white, crystalline, water-soluble solid which in its white hydrated form, $AlCl_3 \cdot 6H_2O$, is used chiefly as a wood preservative and in its yellow-white anhydrous form, $AlCl_3$, chiefly as a catalyst.

alu/minum fluosil/icate, *Chem.* a white, water-soluble powder, $Al_2(SiF_6)_3$, used in the manufacture of optical glass and of synthetic sapphires and rubies.

alu/minum hydrox/ide, *Chem.* a white, crystalline, tasteless, water-insoluble powder, $Al(OH)_3$ or $Al_2O_3 \cdot H_2O$, obtained chiefly from bauxite: used in the manufacture of glass, ceramics, and printing inks, in dyeing, and in medicine as an antacid and in the treatment of ulcers. Also called **alu/minum hy/drate,**

Chem. a white,

alu/minum potas/sium sul/fate, *Chem.* alum (def. 1).

alu/minum sil/icate, any of a group of naturally occurring, water-insoluble substances, obtained from clay or synthesized, containing varying amounts of oxides of aluminum and silicon, Al_2O_3 and SiO_2, and used in the manufacture of glass, ceramics, paints, printing inks, rubber, and plastics. Cf. **mullite.**

alu/minum sul/fate, *Chem.* a white, crystalline, water-soluble solid, $Al_2(SO_4)_3$, used chiefly as a water-purifying agent, as a mordant, and as a size in the manufacture of paper.

a·lum·na (ə lum/nə), *n.*, *pl.* -nae (-nē). a girl or woman who is a graduate or former student of a specific school, college, or university. [< L: foster daughter, pupil; fem. of ALUMNUS]
—**Usage.** See **alumnus.**

a·lum·nus (ə lum/nəs), *n.*, *pl.* -ni (-nī). a graduate or former student of a specific school, college, or university. [< L: foster son, pupil, equiv. to *al-* (s. of *alere* to feed, support) + -u- + *-mnus*, orig. passive participial suffix, akin to Gk *-menos*; see PHENOMENON]
—**Usage.** A male graduate is an ALUMNUS (plural ALUMNI) and a female graduate is an ALUMNA (plural ALUMNAE). When referring to male and female graduates together, the masculine form ALUMNI is used.

al·um·root (al/əm rōōt/, -rŏŏt/), *n.* **1.** any of several North American, saxifragaceous herbs of the genus *Heuchera*, esp. *H. americana.* **2.** the root of any of these plants, used as an astringent. **3.** Also called **chocolate-flower.** a perennial herb, *Geranium maculatum*, of the eastern U.S., having rose-purple flowers. [ALUM + ROOT¹]

A·lun·dum (ə lun/dəm), *n.* *Trademark.* a substance consisting of fused alumina, used chiefly as an abrasive and as a refractory.

al·u·nite (al/yə nīt/), *n.* a mineral, a hydrous sulfate of potassium and aluminum, $KAl_3(SO_4)_2(OH)_6$, commonly occurring in fine-grained masses. [< F *alun* (< L *alūmen* ALUM) + -ITE¹]

a·lu·no·gen (ə lōō/nə jən), *n.* a mineral, hydrous sulfate of aluminum, $Al_2(SO_4)_3 \cdot 18H_2O$, occurring as a white, fibrous crust on quarry or mine walls. [< F *alun* (see ALUNITE) + -O- + -GEN]

al·ure (al/yər, ə lŏŏr/), *n.* a passageway, as the walk along one side of a cloister. Also, **allure.** [ME *al(o)ur* < OF *aleor* passage, equiv. to *ale* walk (see ALLEY¹) + *-or* -URE]

al·u·ta·ceous (al/yə tā/shəs), *adj.* **1.** *Zool.* covered with minute cracks or wrinkles and having a pale, leathery-brown color. **2.** having the color of soft brown leather. [< LL *alūtācius*, equiv. to L *alūt(a)* leather softened with alum + *-ācius* -ACIOUS (altered to -ACEOUS)]

al-Uz·za (äl ōōz/zä), *n.* a pre-Islamic Arabian goddess personifying the planet Venus and considered to be a daughter of Allah.

Al·va (al/və; *Sp.* äl/vä), *n.* **1.** Also, **Alba. Fer·nan·do Al·va·rez de To·le·do** (fer nän/dō äl/vä reth/ de tō-le/thō), **Duke of,** 1508–82, Spanish general who suppressed a Protestant rebellion in the Netherlands in 1567. **2.** a town in NW Oklahoma. 6258 (1960). **3.** a boy's or girl's given name.

Al·vah (al/və), *n.* a boy's given name.

Al·van (al/vən), *n.* a boy's given name.

Al·var (äl/vär), *n.* (*sometimes l.c.*) *Hinduism.* (in southern India) a holy person of the Vaishnava sect. [< Tamil *Ārvār*, deriv. of *āz-* to be deep in contemplation]

Al·va·ra·do (äl/vä rä/thō), *n.* **1. A·lon·so de** (ä lōn/sō de), c1490–1554, Spanish soldier in the conquests of Mexico and Peru; governor of Cuzco 1552?–54. **2. Pe·dro de** (pe/thrō de), 1495–1541, Spanish soldier; chief aide of Cortes in conquest of Mexico; governor of Guatemala 1530–34.

Al·va·rez Quin·te·ro (äl/vä reth/ kēn te/rō), **Joa·quín** (hwä kēn/), 1873–1944, and his brother **Se·ra·fín** (se/rä fēn/), 1871–1938, Spanish dramatists and coauthors.

Al·va·ro (äl vä/rō), *n.* **Cor·ra·do** (kôr rä/dō), c1890–1956, Italian journalist and novelist.

al·ve·at·ed (al/vē ā/tid), *adj.* having the vaulted shape of a beehive. [< L *alveāt(us)* (*alve(us)* concave vessel, trough, equiv. to *alv(us)* belly + *-eus* + *-ātus* -ATE¹) + -ED³]

alveol-, var. of alveolo- before a vowel.

al·ve·o·la (al vē/ə lə), *n.*, *pl.* -lae (-lē/). *Bot., Zool.* **1.** a small cavity, cell, or pit on the surface of an organ. **2.** an alveolus. [< NL; L *alveolus*; see ALVEOLUS]

al·ve·o·lar (al vē/ə lər), *adj.* **1.** *Anat., Zool.* of or pertaining to an alveolus or to alveoli. **2.** *Phonet.* articulated with the tongue touching or close to the alveolar ridge, as *t, d, n*; gingival. —*n.* **3.** *Phonet.* an alveolar sound. [ALVEOL- + -AR¹] —al·ve/o·lar·ly, *adv.*

alve/olar arch/, the part of the upper or lower jawbone in which the teeth are set.

alve/olar ridge/, the ridgelike border of the upper and lower jaws containing the sockets of the teeth. Also called **alve/olar proc/ess.**

al·ve·o·late (al vē/ə lit, -lāt/), *adj.* having alveoli; deeply pitted, as a honeycomb. Also, **al·ve/o·lat/ed.** [< L *alveolāt(us)*. See ALVEOL-, -ATE¹] —al·ve/o·la/tion, *n.*

alveolo-, a combining form of alveolus: *alveolodental.* Also, *esp. before a vowel,* **alveol-.**

al·ve·o·lus (al vē/ə ləs), *n.*, *pl.* -li (-lī/). *Anat., Zool.* **1.** a little cavity, pit, or cell, as a cell of a honeycomb. **2.** an air cell of the lungs, formed by the terminal dilation of tiny air passageways. **3.** one of the terminal secretory units of a racemose gland. **4.** the socket within the jawbone in which the root or roots of a tooth are set. [< L, equiv. to *alve(us)* concave vessel + *-olus*, var. of *-ulus* -ULE]

Al·ve·ra (al vēr/ə), *n.* a girl's given name, form of Elvira. Also, **Alvira.**

Al·vin (al/vin), *n.* **1.** a town in S Texas. 5643 (1960).

THE RANDOM HOUSE DICTIONARY of the ENGLISH LANGUAGE

JESS STEIN
Editor in Chief

LAURENCE URDANG
Managing Editor

TENSILE STRENGTH OF METALS

(Selected from Smithsonian Tables.)

Given in pounds per square inch. The values can be considered only as approximations.

Metal	Tensile Strength in lbs. per sq. in.
Aluminum wire	30000–40000
Brass wire	50000–150000
Bronze wire, phosphor, hard drawn	110000–140000
Bronze wire, silicon, hard drawn	95000–115000
Bronze	60000–75000
Cobalt, cast	33000
Copper wire, hard drawn	60000–70000
German silver	40000–50000
Gold wire	20000
Iron, cast	13000–33000
Iron wire, hard drawn	80000–120000
Iron wire, annealed	50000–60000
Lead, cast or drawn	2600–3300
Magnesium, hard drawn	33000
Monel metal, cold drawn	80000–100000
Nickel, hard drawn	155000
Palladium	39000
Platinum wire	50000
Silver wire	42000
Steel	40000–330000
Steel wire, maximum	460000
Steel, specially treated nickel steel	250000
Steel, piano wire, 0.033 in. diam.	357000–390000
Steel, piano wire, 0.051 in. diam.	325000–337000
Tantalum	130000
Tin, cast or drawn	4000–5000
Tungsten, hard drawn	590000
Zinc, cast	7000–13000
Zinc, drawn	22000–30000

HARDNESS

MOHS' SCALE OF HARDNESS

1 Talc
2 Rock salt or gypsum
3 Calcite
4 Fluorite
5 Apatite
6 Feldspar
7 Quartz
8 Topaz
9 Corundum
10 Diamond

HARDNESS OF MATERIALS

Agate	6–7	Calcite	3
Alabaster	1.7	Calcium	1.5
Alum	2–2.5	Carbon	10.0
Aluminum	2–2.9	Carborundum	9–10
Alundum	9+	Cesium	0.2
Amber	2–2.5	Chromium	9.0
Andalusite	7.5	Copper	2.5–3
Anthracite	2.2	Corundum	9
Antimony	3.0–3.3	Diamond	10
Apatite	5	Diatomaceous earth	1–1.5
Aragonite	3.5	Dolomite	3.5–4
Arsenic	3.5	Emery	7–9
Asbestos	5	Feldspar	6
Asphalt	1–2	Flint	7
Augite	6	Fluorite	4
Barite	3.3	Galena	2.5
Bell-metal	4	Gallium	1.5
Beryl	7.8	Garnet	6.5–7
Bismuth	2.5	Glass	4.5–6.5
Boric acid	3	Gold	2.5–3
Boron	9.5	Graphite	0.5–1
Brass	3–4	Gypsum	1.6–2
Cadmium	2.0	Hematite	6
Calamine	5	Hornblende	5.5

HARDNESS (Continued)

Indium	1.2	Pyrite	6.3
Iridium	6–6.5	Quartz	7
Iridosmium	7	Rock salt (halite)	2
Iron	4–5	Rose' metal	2.5–3.0
Kaolinite	2.0–2.5	Rubidium	0.3
Lead	1.5	Ruthenium	6.5
Lithium	0.6	Selenium	2.0
Loess (0°)	0.3	Serpentine	3–4
Magnesium	2.0	Silicon	7.0
Magnetite	6	Silver	2.5–7
Manganese	5.0	Silver chloride	1.3
Marble	3–4	Sodium	0.4
Meerschaum	2–3	Steel	5–8.5
Mica	2.8	Stibnite	2
Opal	4–6	Strontium	1.8
Orthoclase	6	Sulfur	1.5–2.5
Osmium	7.0	Talc	1
Palladium	4.8	Tellurium	2.3
Phosphorus	0.5	Tin	1.5–1.8
Phosphorbronze	4	Topaz	8
Platinum	4.3	Tourmaline	7.3
Plat-iridium	6.5	Wax (0°)	0.2
Potassium	0.5	Wood's metal	3
Pumice	6	Zinc	2.5

COMPARISON OF HARDNESS VALUES OF VARIOUS MATERIALS ON MOHS AND KNOOP SCALES*

Compiled by Laurence S. Foster

Substance	Formula	Mohs value	Knoop value
Talc	$3MgO \cdot 4SiO_2 \cdot H_2O$	1	
Gypsum	$CaSO_4 \cdot 2H_2O$	2	32
Cadmium	Cd	..	37
Silver	Ag	..	60
Zinc	Zn	..	119
Calcite	$CaCO_3$	3	135
Fluorite	CaF_2	4	163
Copper	Cu	..	163
Magnesia	MgO	..	370
Apatite	$CaF_2 \cdot 3Ca_3(PO_4)_2$	5	430
Nickel	Ni	..	557
Glass (soda lime)		..	530
Feldspar (orthoclase)	$K_2O \cdot Al_2O_3 \cdot 6SiO_2$	6	560
Quartz	SiO_2	7	820
Chromium	Cr	..	935
Zirconia	ZrO_2	..	1160
Beryllia	BeO	..	1250
Topaz	$(AlF)_2SiO_4$	8	1340
Garnet	$Al_2O_3 \cdot 3FeO \cdot 3SiO_2$	..	1360
Tungsten carbide alloy	WC, Co	..	1400–1800
Zirconium boride	ZrB_2	..	1550
Titanium nitride	TiN	9	1800
Tungsten carbide	WC	..	1880
Tantalum carbide	TaC	..	2000
Zirconium carbide	ZrC	..	2100
Alumina	Al_2O_3	..	2100
Beryllium carbide	Be_2C	..	2410
Titanium carbide	TiC	..	2470
Silicon carbide	SiC	..	2480
Aluminum boride	AlB	..	2500
Boron carbide	B_4C	..	2750
Diamond	C	10	7000

* Acknowledgment is made to N. W. Thibault, Norton Company, Worcester, Massachusetts, for many of Knoop hardness values. Cf. R. F. Geller, "A Study of Ceramics for Nuclear Reactors," Nucleonics, Vol. 7, No. 4, Table 1, pp. 8–9 (Oct. 1950). V. E. Lysaght, *Indentation Hardness Testing*, Reinhold 1949.

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